

SOME CHARACTERISTICS OF A POPULATION
OF STUNTED PERCH *R. WILLIAM ESCHMEYER

AN EXAMINATION of the pothole lakes in the Pigeon River State Forest, Otsego and Cheboygan counties, made by the Institute for Fisheries Research in 1932 showed that several of these small lakes contained an abundance of yellow perch (*Perca flavescens*); several others contained only minnows, or minnows and brook trout where the latter had been planted. In 1933 most of these lakes were stocked with trout. Subsequent study indicated that the survival and growth of the trout were good in lakes which did not contain perch, but were poor in those in which perch were abundant. It was observed that, in general, the perch were in poor condition; most of those taken were small and thin. The lakes which contain perch are fished very little, but those with only trout (and minnows) provide excellent fishing.

It was decided, in 1934, to make an effort to remove the fish from one of these perch lakes after poisoning and to stock it later with trout. South Twin Lake, T. 32 N., R. 1 W., Section 10, was selected for the experiment. This lake, according to the Institute's 1932 survey, has an area of 4.3 acres (1.74 hectares) and a maximum depth of 12.7 meters. The outline is roughly circular, and the basin is bowl-shaped, with limited shoal area. It was determined also that in summer the water is definitely stratified, with the thermocline at a depth of from 4 to 7 meters. The bottom soil at the margin is sand, in deeper water it is organic (pulpy peat). The water is relatively clear (Secchi disk reading 7.5 meters) and is alkaline (surface pH 8.7). This small, land-locked lake has high, steep, sandy banks, and the drainage area is very small.

Gill nets of seven mesh sizes varying from $1\frac{1}{4}$ to 4 inches, stretched measure, were fished in this lake several weeks before the poisoning,

* Contribution from the Institute for Fisheries Research of the Department of Conservation and the University of Michigan.

and five sticks of dynamite were discharged at the same time. The perch obtained by these two methods were placed in one lot (Lot 4 of this study).

On the morning of September 20, 1934, an Institute party consisting of Milton B. Trautman and the writer distributed about 48 pounds of powdered derris root (5 per cent rotenone content) over the surface of the lake. Most of the poison was spread by pouring it in the wake of an outboard motor. The remainder was broadcast by hand. About eight hours after the poison had been distributed 100 sticks of 40 per cent dynamite were discharged in deep water (in three lots of approximately 25, 25, and 50 sticks) in order to assure a thorough circulation of the poison throughout the lake.

The poison had killed a considerable number of fish before the dynamite was discharged. Many of these perch were collected and are included here as Lot 1. Another lot (Lot 2) was collected on the same day, but after the dynamiting. Lot 3 was collected on the following day. Most of the fish which floated, or which sank in shallow water, were recovered. To check the effectiveness of the poison and the dynamite, a gill net with the same mesh sizes as the one previously used was set in the lake overnight several weeks later, but it took no fish. A live perch was seen, however, at the time the net was lifted. Not all the perch were killed and not all of those killed were recovered.

The perch in all four lots were preserved in 10 per cent formalin and were later transferred to 70 per cent alcohol. All studies of them were made from preserved specimens. In addition to the perch a few trout were taken by netting and two were recovered after poisoning. No other species were taken or are known to have been present. Data concerning the trout are not included in this study.

The purpose of this paper is to describe some of the characteristics of this population of stunted perch, based on the collection obtained by the several methods indicated above. Unfortunately, the entire population could not be collected for study. The fish came to the surface when dying, and wave action tended to wash the dead ones toward the shore region, where they continued to float or sank in shallow water. Although a precise estimate of the percentage of the total population recovered is not possible, it is believed that the percentage is relatively large (well over 50 per cent).

TOTAL POPULATION

The four lots included a total of 3,615 perch. In addition, 503 perch were counted lying on the bottom after the last lot had been recovered. A total of 4,118 fish are, therefore, definitely known to have been present in the lake. This number represents 955 perch per acre. Since not all the fish were seen or recovered, the total population was unquestionably well in excess of 1,000 fish per acre.

The 3,615 perch had a total weight of 109.3 pounds (49,591 grams). This represents a weight of 25.4 pounds per acre. If the 503 perch which were seen but not collected were of the same average weight, they represented a total of 15.2 pounds, increasing the total weight per acre to about 29 pounds. The weight of the entire population was most probably well in excess of 30 pounds per acre.

SIZE AND AGE DISTRIBUTION

Weight, length, and age were determined for all specimens. Both standard and total lengths were recorded to the nearest millimeter. The fish were weighed on a Welch balance which was calibrated to tenths of grams. The small fish were weighed in groups of 2 to 90 fish per group, but all fish older than the II group were weighed individually. The length distribution, irrespective of age or sex, is shown in Table I, where the fish are grouped by 10-mm. intervals. The pronounced mode at 80-89 mm. suggests that most of the fish probably belonged to one age group. Another mode at 110-119 mm. suggests the presence of another age group; however, this second mode actually consists of fish of several age groups.

Ages were determined for all the 3,615 fish by examination of the scales by means of a binocular microscope. The annuli were located easily in the young fish (I and II groups), but were difficult to find in the scales from some of the older fish, especially in those from individuals in poor condition, since many of these emaciated individuals had apparently partially resorbed portions of their scales (see Pl. LXVI, Fig. 2). On some specimens a large number of scales were examined before the age could be determined with any degree of certainty. Even though the scales were studied carefully, it is possible that the age determinations on some of the older fish were incorrect.

TABLE I

SIZE DISTRIBUTION OF ALL PERCH, SEXES COMBINED,
BY 10-MILLIMETER CLASSES (STANDARD LENGTH)

<i>Size class</i>	<i>Number</i>	<i>Percentage of total</i>
50-59	3	0.1
60-69	0	0.0
70-79	144	4.0
80-89	2270	62.8
90-99	345	9.5
100-109	112	3.1
110-119	357	9.9
120-129	222	6.1
130-139	93	2.5
140-149	32	0.9
150-159	18	0.5
160-169	7	0.2
170-179	3	0.1
180-189	3	0.1
190-199	0	0.0
200-209	0	0.0
210-219	2	0.1
260-269	1	0.0
270-279	1	0.0
280-289	1	0.0
290-299	1	0.0
Total	3615	99.9

The number of perch in each age group is shown in Table II. The ages indicate the number of winter marks (annuli). Since most of the fish were taken in mid-September (20th), the fish were actually almost if not wholly one growing season older than the recorded ages.

Over three fourths (76.7 per cent) of the fish were in one age group (II). There were more fish in the III and IV groups than in the 0 and I groups. The only age group represented by a mode in the length distribution is the II group.

In general, after the second year the females grew more rapidly than the males. In the I group the males were, on the average, longer and heavier than the females. In the II group both sexes were of about equal length and weight, and in all groups older than II the females were decidedly longer and heavier. A few of the female perch reached an exceptionally large size. The single perch in

TABLE II

NUMBER OF FEMALE AND MALE PERCH IN EACH AGE GROUP, AND
AVERAGE LENGTH AND WEIGHT OF FISH IN EACH GROUP

Sex	Age group							
	0	I	II	III	IV	V	VI?	Over VI
Females (1530)								
Lot 1.....	2	27	607	24	66	13	..	2
Lot 2.....	..	..	284	4	31	3	..	..
Lot 3.....	..	..	320	6	31	2	1	..
Lot 4.....	..	1	27	65	13	..	..	1
Total.....	2	28	1238	99	141	18	1	3
Males (2085)								
Lot 1.....	1	45	638	132	11	..	..	..
Lot 2.....	..	3	497	59	32	..	..	..
Lot 3.....	..	10	361	108	42	..	..	..
Lot 4.....	..	13	40	84	9	..	..	..
Total.....	1	71	1536	383	94	..	..	..
Total (both sexes)	3	99	2774	482	235	18	1	3
Percentage of total collection.....	0.1	2.7	76.7	13.3	6.5	0.5	0.0	.1
Average standard length in mm.								
Females.....	44	80.4	87.1	125.0	134.2	169.1	274.0	282.0
Males.....	43	89.0*	84.4	116.0	121.1	.....	.....	.....
Average weight in grams								
Females.....	2.7	7.7	9.6	30.2	35.3	76.5	445.3	443.3
Males.....	2.7	11.3*	9.7	21.7	25.0	.....	.....	.....
Average (approx.) total length in inches								
Females.....	2.1	3.8	4.1	5.9	6.3	7.88	12.49	13.83
Males.....	2.0	4.2	4.0	5.5	5.7	.....	.....	.....
Average weight in ounces								
Females.....	0.09	0.27	0.34	1.07	1.25	2.70	15.73	15.65
Males.....	0.09	0.40	0.37	0.77	0.89	.....	.....	.....

* A number of the males in the I group showed exceptionally rapid growth as compared with the older fish and with other members of the same age group.

the VI? group weighed more than 45 perch in the II group and almost as much as 18 average-sized male perch from the oldest group of males (IV). In his study of perch in three northern Wisconsin lakes Schneberger (1935) found that the females grew much faster than the males in Silver Lake, the lake with the slowest-growing population. This is in accord with data for South Twin Lake perch. In the two Wisconsin lakes (Weber Lake and Nebish Lake) where the fish grew more rapidly the difference in growth rate of the two sexes was much less pronounced.

The dominant group (II) averaged only slightly over four inches in total length, and only a little over a third of an ounce in weight.

Some of the males in the I group grew very rapidly as compared with the other fish of the same age and sex. This rapid growth of a few individuals raised decidedly the average length and weight for this group. Such unusual growth was present also in a few of the perch of the II group, but was not observed in the older fish. Schneberger (1935) noted a similar rapid growth in some of the young fish of the perch of Wisconsin lakes. He stated that "In the younger fish [age groups II and III] cases are found where the annulus is far from the focus, indicating an extremely rapid growth. However, this type is rarely found in the older fish, suggesting that the rapid growers are shorter-lived."

The approximate number of legal-sized fish in the South Twin Lake perch population was calculated. Since all the perch were measured after they were preserved, it is impossible to determine exactly the number of fish of a given length because the amount of shrinkage is not known. However, an approximate correction for shrinkage after preservation was obtained through the application of the shrinkage factor, 1.016, determined by Van Oosten (1929) for the lake herring. The legal length for perch in Michigan is 152.4 mm. (6 inches). This figure divided by the shrinkage factor equals 150 mm. Accordingly, all perch with a length of 150 mm. or more (after preservation) are here considered to be of legal length. The number, age, and average length of all perch 150 mm. or more in length are shown in Table III. The percentage of legal fish in each age group is presented also.

If the allowance for shrinkage was correct, 7 per cent of all the fish collected, or approximately 60 fish per acre, were of legal length. The ratio of legal females to legal males was approximately 4 to 1

TABLE III

NUMBER, AGE, AND SEX OF ALL LEGAL-SIZED PERCH
(With total length of 150 mm. or more when preserved)

Number and percentage of all fish in age groups	Age group											
	II		III		IV		V	VI?	Over VI	Total		
	Male	Female	Male	Female	Male	Female	Female	Female	Female	Male	Female	Both sexes
Number	4	1	31	50	19	126	18	1	3	54	199	253
Percentage . .	0.3	0.1	8.1	50.1	20.2	89.4	100	100	100	2.6	13.0	7.0

(199 to 54). Since some of these fish had very large heads and were in poor condition, and since some were parasitized rather heavily (Pl. LXVI, Fig. 1), the percentage of desirable legal-sized fish in the total population was very small, certainly less than 5 per cent.

For comparison of growth of the South Twin Lake perch with perch from other waters the lengths of this species at different ages

TABLE IV

AVERAGE STANDARD LENGTH IN MILLIMETERS OF PERCH IN VARIOUS AGE GROUPS FROM SEVERAL LAKES (ADAPTED FROM SEVERAL AUTHORS)

Investigator	Lake	Age group				
		I	II	III	IV	V
Eschmeyer	South Twin	87	86	118	129	169
Harkness	Lake Erie	...	144	168	187	217
Hile *	Wawasee (Ind.)	86	129	167	198	220
Jobes †	Lake Erie	161	178	196	213	250
Schneberger ‡	Nebish (Wis.)	124	157	173	209	245
Schneberger §	Weber (Wis.)	...	130	158	174	191
Schneberger ||	Silver (Wis.)	...	109	120	145	173

* Data for 1926, 1927, 1928 combined.

† Data for 1927 and 1928 combined.

‡ Data for 1930, 1931, 1932 combined.

§ Data for 1928, 1930, 1931, 1932 combined.

|| Data for 1928, 1930, 1931 combined.

as determined by Harkness (1922), Hile (1931), Jobes (1933), and Schneberger (1935) are recorded in Table IV. In all these studies the lengths given are measured lengths of fish taken in the summer or the fall. It will be noted that, in general, the perch from South Twin Lake grew much more slowly than those from the other lakes. This slow growth is brought out in a striking manner by comparison with Jobes' data for the Lake Erie perch. In Lake Erie the perch had attained an average size in the II group greater than that of the South Twin Lake perch in the V group.

SEX RATIO

For the entire population the sex ratio was 74 females per 100 males, or approximately a 3 to 4 ratio. The ratios for the different lots were:

Lot 1.....	89 females per 100 males
Lot 2.....	54 females per 100 males
Lot 3.....	69 females per 100 males
Lot 4.....	74 females per 100 males

The ratios vary considerably from one lot to another. Incidentally, Lot 4, the smallest lot, showed a proportion of females to males identical with the proportion of the two sexes for all lots combined. It is possible that the poisoning was selective or that one sex floated more readily than the other after being killed. However, if the poisoning was no more selective than capture by gill nets or other methods used to take fish, the data suggest that apparently random samples of a perch population may lack reliability in respect to the sex ratio. It is possible that, at certain times of the year at least, these fish school in separate sexes.

In this slow-growing population of perch the larger fish tended to be predominantly females. The fish with five or more annuli were all females. In the IV group the females predominated, but in the I, II, and III groups males were decidedly more abundant than females. Apparently the females had a considerably longer life span than the males, a condition which is common among fishes and among many other forms of animal life as well. Geiser (1924) held that females are inherently better fitted than males to survive adverse environmental conditions. Schneberger (1935) found the large fish to be predominantly females in two of the three Wisconsin perch populations examined by him. Three of the four cisco (*Leu-*

cichthys artedi) populations of northern Wisconsin lakes studied by Hile (1936) showed a preponderance of females. Hile stated, further, that "with the exception of the irregular data on Silver Lake the females tend to become relatively more abundant as age increases."

These observations offer strong support to the suggestion that in analyzing a given sample of fish with respect to sex ratio the age composition must be given consideration. Had gill nets been used to obtain the sample in South Twin Lake most of the young fish would not have been captured and females would have been found relatively more abundant. The scarcity of young fish in Schneberger's samples of perch from Wisconsin lakes probably accounts for the disagreement between his data on the sex ratios in the species and those obtained for South Twin Lake. Schneberger found the ratio of females to males to be 100:126 in Nebish Lake, 100:76 in Weber Lake, and 100:71 in Silver Lake. The conclusions were based on 355, 407, and 392 fish respectively. Silver Lake, with the greatest concentration of perch and with the slowest-growing perch, had the largest proportion of females (58 per cent). It is possible that his sex ratios would have been decidedly different had he been able to examine a larger number of young fish. The fact that the perch in South Twin Lake were dominantly young fish (primarily of the II group) certainly had a bearing on the sex ratio found for the fish in that lake and on the disagreement with Schneberger's results.

CONDITION OF PERCH¹

The coefficient of condition, or "index of relative heaviness," was determined for individual fish. The formula $K = \frac{W \times 10^6}{L^3}$ was used, where W = weight in grams and L = standard length in millimeters.

Since the small size of the perch in the age groups 0, I, and II made it impractical to weigh all these individually, the values of K for fish in these age groups are only approximate. The values of K were calculated individually for all older fish. Table V shows the value of K for each age group.

The values of K were identical for the males and the females in the I group. In the II group the males were in slightly better

¹ Discussions of coefficient of condition and length-weight relationship are found in papers by Hile (1936) and others.

TABLE V
AVERAGE VALUE OF *K* FOR PERCH IN EACH AGE GROUP *

Sex	Age group †							
	I	II	III	IV	V	VI?	Over VI	Average
Females	1.49	1.46	1.51	1.42	1.46	2.17	1.97	1.46
Males	1.49	1.51	1.41	1.41	....	....	....	....
Both sexes . .	1.49	1.49	1.43	1.42	1.46	2.17	1.97	1.46

* Number of perch in each group shown in Table II.

† 0 group not included in this table.

condition, but in the groups older than II the condition of the females was better than that of the males. The fish as a whole were in poorest condition in the III and IV groups.

The distributions of the individual values of *K* were determined for each sex in each age group older than II. Without presentation of the extensive tabular material it may be stated that for most groups the distribution is approximately that of a normal curve. In the population as a whole the condition varies over a wide range — from a minimum of less than 1.0 to a maximum of over 2.0. The two extremes for females are shown in Plate LXV.

A comparison of the condition of the South Twin Lake perch with that of perch in other waters as determined by Schneberger and Hile is presented in Table VI. The fish from all the lakes were collected in summer or fall. It will be noted that, with the exception of the Weber Lake II group, the condition of perch from South Twin Lake was poorer than that in the other four lakes. In making comparisons of the *K* values for South Twin Lake perch with those of other populations, it should be remembered that all the Twin Lake perch were weighed after preservation. There is a strong possibility that the Twin Lake perch may have lost weight on preservation and that, consequently, the recorded values found for *K* may be too low. That fish do lose weight on preservation is indicated by the observations of Hile (1936), who found the shrinkage factor for the weight of cisco in one lake (Muskellunge) to be 1.181, and in another lake (Clear), 1.144. Data on the actual shrinkage of perch on preservation are not available.

TABLE VI

VALUE OF *K* FOR PERCH IN THREE WISCONSIN LAKES AND ONE INDIANA LAKE AS COMPARED WITH VALUE OF *K* FOR THE PERCH OF SOUTH TWIN LAKE

Investigator	Lake	Age group				
		I	II	III	IV	V
Eschmeyer	South Twin	1.49	1.49	1.43	1.42	1.46
Hile *	Wawasee (Ind.)	1.51	1.63	1.60	1.77	1.70
Schneberger †	Nebish (Wis.)	1.67	1.64	1.63	1.72	1.75
Schneberger †	Weber (Wis.)	1.65	1.44	1.54	1.61	1.65
Schneberger †	Silver (Wis.)	....	1.57	1.60	1.61	1.65

* Data for 1926, 1927, 1928, and 1929 combined.

† Data for 1930, 1931, and 1932 combined.

HEAD LENGTH

Repeated observations of systematists suggest that in normally growing fresh-water fishes the head grows relatively more slowly than the body. In the South Twin Lake perch, however, the

TABLE VII

HEAD LENGTH (B/H)

Extreme head length in standard length

Sex	Age group						
	I	II	III	IV	V	VI?	Over VI
Females							
Number.....	1	28	76	78	18	1	3
B/H.....	3.20	3.09	2.84	2.86	2.96	2.95	3.06
Males							
Number.....	13	42	121	5	....	....	....
B/H.....	3.11	3.10	2.90	2.78	....	....	....

head generally grew more rapidly, in proportion, than the body (Table VII).

The South Twin Lake perch appear to be unusual also in the possession of a head relatively much larger than that ordinarily recorded for the species. Jordan (1929) indicates that in perch the

head length is contained in the body length $3\frac{1}{4}$ times. The head length of the perch in South Twin Lake was obviously much greater than the head length given by Jordan for this species.

Attention should be called to a possible correlation between the coefficient of condition and head length. A comparison of Tables V and VII suggests that, in general, the fish in poor condition have relatively the larger heads in this slow-growing population. The III and IV groups were in poorest condition (Table V); these same two groups had, relatively, the largest heads (Table VII).

Because of the relatively large heads in this slow-growing population it was considered possible that the slow growth itself might be responsible for the large heads. If this were true, the more rapidly growing fish of an age group might be expected to have the smallest heads. However, a study of the head length for 128 specimens of the III group indicates that the head length varies little with differences in growth, although there is a suggestion that the head is larger in the faster-growing fish (130 to 150 mm.). Because of the small number of specimens the averages for some of the intervals lack reliability. The average sizes of heads for fish of different lengths are shown in Table VIII.

TABLE VIII

HEAD LENGTH (B/H) OF PERCH IN VARIOUS SIZE GROUPS

All specimens belong to one age group (III).

<i>Group interval in mm.</i>	<i>Number of specimens</i>	<i>B/H</i>
105-109	6	2.90
110-114	33	2.87
115-119	67	2.86
120-124	25	2.85
125-129	10	2.88
130-134	7	3.11
135-139	2	2.93
140-144	3	2.97

FOOD

No study was made of the abundance of food organisms in the lake, but the stomach contents of a number of fish were examined. The stomachs of a considerable proportion of the larger fish contained perch, most of which were undigested. Very possibly, how-

ever, such a large number of fish may not normally contain perch in their stomachs. It is probable that the smaller perch were incapacitated by the poison before the large fish were affected and were, therefore, easily captured by the large individuals. In spite of the fact that the abundance of young perch in the stomachs of the larger fish was probably much higher than normal, the small perch obviously are an important food item for the large individuals. It is possible that the excellent condition of the larger females (part of the IV group and all older than the IV) is attributable to the presence of the abundant supply of perch (chiefly the II group) small enough to be taken by them.

A stomach analysis of 34 fish of the I group indicated that insect larvae and nymphs and small crustaceans constituted almost the entire food supply. Chironomids and Cladocera were the most common organisms. The insects included also Diptera (other than Chironomidae), Ephemera, Trichoptera, Coleoptera, and Odonata. The stomachs generally contained relatively little food, but only one of the 34 was completely empty. It was observed, further, that individual stomachs contained either insects or crustaceans; none were found to contain both forms.

Analysis of stomachs of the II group (50 specimens) showed that the food of this group is essentially the same as that of the I group, except that a greater proportion of the stomachs contained crustaceans. The insects included chiefly immature Diptera and Ephemera. A few Trichoptera were also eaten. The Crustacea were mostly Cladocera.

Stomachs of 40 fish of the III group were examined. The bulk of the food consisted of Diptera larvae and nymphs, with Chironomidae and Corethera predominating. Some small snails and small clams were eaten, along with leeches, algae, Trichoptera, Hemiptera, and Hymenoptera. Six of the stomachs were empty.

The food in the stomachs of 40 fish in the IV group was essentially similar to that of the III group. The most important items were Diptera, with Corethera predominating. Other forms, such as snails, clams, Odonata, Orthoptera, Coleoptera, Ephemera, Trichoptera, leeches, and crayfish, were taken in very small quantities.

If the population is considered as a whole, it may be stated that at the time the perch were taken Diptera constituted the chief food, with Chironomidae and Corethera apparently supplying the bulk of

it. In general, the stomachs were relatively very small and contained little food. However, only 13 of the 164 stomachs were entirely empty. A scarcity of satisfactory food organisms for perch of intermediate size probably accounts for the slow growth and the poor condition of the fish in this lake.

PERCH CYCLE

There is some reason to believe, although the evidence is not conclusive, that a definite cycle with respect to age and size composition of the stock normally occurred in the population. When the fish were killed over three fourths were of the II group; the 0 and I groups were very poorly represented. It is possible that, because of the paucity of available food, the II group subsisted on the eggs or the young when these were available. Had the fish not been poisoned most of the II group would possibly have died of starvation in the following year, although enough adult fish would probably have survived to assure adequate reproduction. With most of the predators removed by starvation (see below) a large crop of young fish would possibly again have resulted. In such a cycle one age group would be very abundant, would keep down the two following age groups by eating the eggs or young, would die of starvation in its third year, and, in dying, would make possible the survival of another group. The dominant age groups in South Twin Lake for the ten years starting in 1934 would then have been (successively): II, 0, I, II, 0, I, II, 0, I, II, provided the cycle was uniform. The dominant group would invariably have been under legal size (six inches). In reply to a letter addressed to him, Mr. William Horsell, superintendent of the Pigeon River State Forest, stated that in the last eleven years the perch in South Twin Lake had always been small, six inches or less in length.

STARVATION

A number of factors suggest that ordinarily a majority of the fish may have died of starvation. Few fish other than young ones were normally removed by man or by predators, since the lake was fished very little and there were ^{no} predators large enough to take the larger fish. Factors already mentioned which might suggest starvation of a considerable portion of the population are: (1) a decrease in condition in the III and IV groups combined; (2) the poor condition

of the population in general; (3) an unusually large head, especially in the groups in poorest condition; (4) small size of the food organisms in the stomachs, a fact that suggests an apparent scarcity of organisms of a size intermediate between Diptera and small perch (II group); (5) small amount of food in the stomachs (regurgitation may possibly have taken place, however, when the fish were poisoned); (6) apparent resorption of portions of the scales in many of the poorer individuals (see Pl. LXVI, Fig. 2); (7) unusually large proportion of relatively young fish (II group) in the population, despite the fact that cannibalism was probably relatively common. Although they were not studied in detail, a casual examination of the sex organs in the emaciated individuals indicated that in such fish the gonads were relatively very small. Although it cannot be proved definitely that many of the fish normally died of starvation, and although each of the items mentioned above may not in itself suggest starvation, the evidence, considered as a whole, indicates strongly that an inadequate food supply was responsible for an early mortality and a consequent scarcity of old fish.

GENERAL CHARACTERISTICS OF THE POPULATION

Gill nets, poison, and dynamite were employed to reduce in numbers (if possible, to exterminate completely) the perch population of South Twin Lake (Otsego County). Those perch which floated or which sank in shallow water were recovered and were studied by the writer. The study shows that: (1) a total of 955 perch per acre, weighing 29 pounds per acre, were definitely present — the actual number and weight were of course greater than the number accounted for and their weight; (2) 7 per cent were legal fish (54 males, 199 females); (3) the fish grew quite slowly; (4) over three fourths of those recovered belonged to age group II; (5) the proportion of females to males in the entire population was 74 to 100; (6) the young fish were dominantly males, the older ones dominantly females; (7) all fish over four winters old were females; (8) in general, the fish were in poor condition; (9) they had unusually large heads; (10) the fish covered a wide range of condition; (11) Diptera constituted the primary food item of the fish; (12) there was possibly a definite cycle with the dominant age group always of less than legal size; (13) there is some evidence to suggest that most of the fish normally died of starvation.

To what extent the concentration of the fish in South Twin Lake affected their growth and condition could not, of course, be determined. It should be pointed out, however, that this very dense population of perch has the slowest growth of all perch populations for which there are published records.

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FIG. 1. Perch of IV group (extremes). The two upper perch were large enough to eat perch of the three lower perch were too small



FIG. 2. Dorsal view of the same fish shown in Figure 1

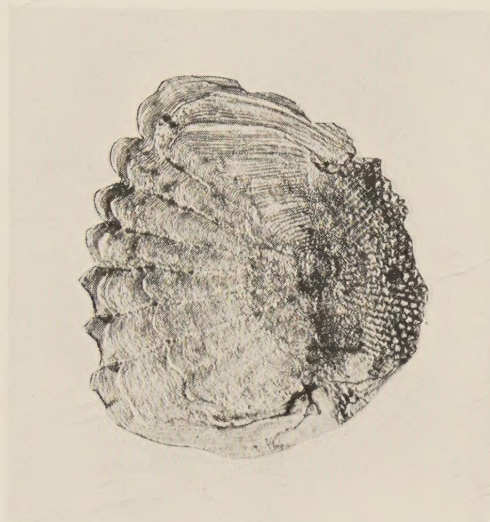


FIG. 2. Scale from slow-growing perch (IV group), indicating partial absorption of scales, with subsequent deposition of scale material

FIG. 1. Perch of II group, showing degrees of parasitism with strigeid larvae (tails retouched)

